
**The Crab-eating fox
Cerdocyon thous (Carnivora: Canidae)
as a predator of amphibians and reptiles
in Brazil: an overview**

Understanding the aspects of trophic ecology can bring relevant information about species' biology, such as foraging

strategies, habitat preference, and morphological adaptations (Pedó et al. 2006), contributing to their conservation. Mammals of the order Carnivora may have omnivorous or totally carnivorous diets (Roemer et al. 2009) and play important roles in processes ranging from the dispersion of seeds (Acevedo-Quintero & Zanora-Abrego 2016) to population control of their prey (Terborgh et al. 2001).

The Crab-eating fox *Cerdocyon thous* (Linnaeus 1766) is a

generalist canid, very flexible about its diet and habitat use (Pedó et al. 2006, Raíces & Bergallo 2010, Monteiro-Alves et al. 2019), which is reflected in its wide distribution in South America and is accordingly classified as Least Concern by IUCN (Lucherini 2015). In Brazil, *C. thous* is widely distributed, occurring in all biomes, including areas of pasture and agriculture, except for some areas of the Amazon Forest (Beisiegel et al. 2013, Lucherini 2015). *Cerdocoyon thous* is crepuscular and nocturnal (Dias & Bocchiglieri 2016), with body weight ranging from 2.7 to 10 kg (Bueno & Mota-Junior 2004, Cheida et al. 2006). It is an omnivore with an opportunistic diet consisting of fruits, insects, crustaceans, and small vertebrates such as birds, mammals, amphibians, reptiles, and carcasses (Facure et al. 2003, Cheida et al. 2006, Gatti et al. 2006, Pedó et al. 2006, Rocha et al. 2008). It is one of the most roadkilled mammals in Brazil (Cherem et al. 2007, Ascensão et al. 2017, Ferreguetti et al. 2020).

Several studies on the diet of the *C. thous* in the Atlantic Forest (Gatti et al. 2006, Pedó et al. 2006, Rocha et al. 2008, Raíces & Bergallo 2010, Rocha-Mendes et al. 2010) still leave knowledge gaps about this mammal, such as the identification of its prey at the level of genus or species. Thus, we aimed to identify the prey composition for roadkilled *C. thous* at the species level at a coastal sand area ("Restinga") in state of Espírito Santo, SE Brazil, and discuss the importance of amphibians and reptiles in the diet of this canid.

We analyzed the stomach contents of three *C. thous* found roadkilled. They were collected in October and November 2016 and donated to us by the Concessionaire Rodovia do Sol S/A, which manages the Rodovia do Sol, a 67,5 km stretch of the ES-060 road that connects the cities of Vitória and Guarapari, beginning at km 0 in Vitória (20°18'43.74"S, 40°17'38.64"W, datum WGS 84; 2 m a.s.l.), on the Ponte Deputado Darcy Castelo de Mendonça (a.k.a. Third bridge), crosses the municipality of Vila Velha and ends at km 67.5, in Meaípe, municipality of Guarapari (20°44'31.14"S, 40°33'7.39"W, m a.s.l.) along the coast of the state of Espírito Santo, southeastern Brazil. Rodovia do Sol crosses two important protected areas of Restinga: the Parque Estadual Paulo César Vinha (PEPCV; from 20°32'5.71"S, 40°23'13.24"W to 20°37'17.85"S, 40°25'59.31"W) and the Área de Proteção Ambiental de Setiba (APA Setiba; from 20°31'22.39"S, 40°22'23.68"W to 20°36'49.03"S, 40°27'16.76"W).

The carcasses were frozen one hour after being collected. We necropsied and removed the stomach contents of each specimen and fixed and conserved them in 70% alcohol. We identified prey species based on morphological characters and available literature. Moreover, we extensively reviewed the literature on amphibians and reptiles reported as diet items of the Crab-eating fox *Cerdocoyon thous*.

The stomach content revealed four South American striped blindsnake *Amerotyphlops brongersmianus* (Vanzolini 1976) (Fig. 1) and one amphibian species, the Butter frog *Leptodactylus latrans* (Steffen 1815) (Fig. 2). One *C. thous* had ingested two *A. brongersmianus* and *L. latrans*, while the others had ingested one *A. brongersmianus* each.

The snake *A. brongersmianus* was identified according to Dixon & Hendricks (1979). Hence, pholidosis used to confirm the species were: preocular contacting supralabials 2 and 3; 11

dorsal scales rows; scale rows 20–20–20, number of dorsal scales from rostral to tail spine, and morphology of head dorsal scales. The adult *L. latrans* was represented by non-intact parts of a hind limb (tibia + tarsus + foot) and a forelimb (forearm + hand). Despite of the characteristic color pattern of limbs, the hand had the characteristic prepollex with corneous spines (Fig. 2), and the adult stage was defined according to the proportional size of found body pieces.



Figure 1. South American striped blindsnake (*Amerotyphlops brongersmianus*) found in the stomachs of three *C. thous* from Guarapari, state of Espírito Santo, Brazil. A. Two specimens found in a single canid; B. Two specimens found in one canid each.



Figure 2. Remains of a Butter frog *Leptodactylus latrans* found in the stomach of one *C. thous* from Guarapari, state of Espírito Santo, Brazil. At the top, the partial hind limb with the tibia, tarsus, and foot; at the bottom, the partial forelimb with forearm and hand with the prepollex with corneous spines (red arrows).

The consumption of herpetofauna by *C. thous* is well known (see below). As a generalist mammal, it consumes a wide array of food items; the quality and proportions in the diet differ according to location, availability, and seasonality

(Facure et al. 2003, Bueno & Motta-Junior 2004, Gatti et al. 2006, Pedó et al. 2006). At the Restinga, such as at the PEPCV, its diet includes fruits, vertebrates, and invertebrates (Raíces & Bergallo 2010), whereas in anthropic environments and regenerating habitats, this canid can consume a large proportion of poultry, human waste, and cultivated fruits (Courtenay & Maffei 2004).

Amphibians and reptiles can often be consumed, although they are not always the most abundant items in this canid's diet. At a Caatinga biome, Gomes et al. (2012) identified *Vanzosaura rubricauda* (Boulenger 1902) and *Tropidurus* sp., and Souza & Bocchiglieri (2018) identified the Blind snake *Epictia borapeliotes* (Vanzolini 1996), in both cases, from fecal samples of *C. thous*. It has also predated venomous snakes such as *Bothrops* spp. (Bossi et al. 2018) and Central American rattlesnakes *Crotalus durissus* Linnaeus 1758 (Souza & Bocchiglieri 2019), which may indicate either the consumption of already dead individuals or resistance to venoms (Rocha et al. 2008, Bossi et al. 2018). Unidentified non-venomous Colubridae snakes have also been reported as diet items (Facure et al. 2003, Bianchi et al. 2014). Only a few studies have determined snakes from the stomach contents of *C. thous* to the species level: South American striped blindsnake *Amerotyphlops brongersmianus*, Urutu *Bothrops alternatus* Duméril, Bibron & Duméril 1854, Jararaca *Bothrops jararaca* (Wied-Neuwied 1824), and Goldbauch-Buntnatter *Erythrolamprus poecilogyrus* (Wied-Neuwied 1825) (Gatti et al. 2006, Rocha et al. 2008, Raíces & Bergallo 2010, Bossi et al. 2018). Furthermore, *C. thous* were observed in a cooperative attack and consumption upon a live adult Red-Tailed *Boa constrictor* Linnaeus 1758 (Silva et al. 2018). In another report, *C. thous* was observed capturing a Military Ground snake, *Erythrolamprus miliaris*, while actively foraging (Gonzalez et al. 2016). Regarding amphibians, Leptodactylidae species (relative volume in the feces = 0,1%) have been reported as very frequent in the diet of *C. thous* in the Pampa biome (Bossi et al. 2018). During the dry season in the Pantanal biome, frogs (12,2%) were also one of the main sources of food for the canid (Bianchi et al. 2014).

Regarding another Restinga, at Parque Nacional de Restinga de Jurubatiba (National Park), in Rio de Janeiro state, the Amazon Lava Lizard *Tropidurus torquatus* (Wied-Neuwied 1820) and Green-tailed Lizard *Glaucmastix littoralis* (Rocha, Bamberg Araújo, Vrcibradic 2000) were reported as *C. thous* preys (Rocha et al. 2008), as well as *A. brongersmianus* (Raíces & Bergallo 2010). For Espírito Santo, Gatti et al. (2006) studied the diet of *C. thous* by analyzing fecal samples from the PEPCV and found amphibians and reptiles, some of them non-identified, and reported species other than our findings, like Amazon Lava Lizard *Tropidurus torquatus*. In long-term monitoring (2012 to 2016) analyzing 25 road-killed *C. thous* from Rodovia do Sol found amphibians and reptiles with a high frequency of occurrence - FO, like Order Anura (FO = 26,1%) and Order Squamata (FO = 21,7%) in their stomach contents. They also found the anuran *L. latrans* and many other amphibians and reptiles but no *A. brongersmianus* (Srbek-Araujo et al. 2021).

Thus, the four specimens of *A. brongersmianus* and one of *L. latrans* we found in the stomach contents of *C. thous* reinforce the generalist habit of this canid and the variation of the diet in each location, demonstrating that it consumes

abundant items, like amphibians and reptiles, especially at the Restinga habitats of Espírito Santo, where these kinds of prey tend to be abundant (Oliveira & Rocha 2015, Castro & Silva-Soares 2016). Moreover, we urge more research on fresh roadkilled predators to increase the ability to identify prey at the species level. Unfortunately, other methods often do not provide such capabilities. Non-invasive studies of diets involving analysis of fecal samples (e.g., Facure et al. 2003, Bueno & Motta-Junior 2004, Gatti et al. 2006, Pedó et al. 2006) unfortunately result in a high degree of decomposition of the consumed items (Gonzalez et al. 2016) and, consequently, difficulty in prey identification to the species level.

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